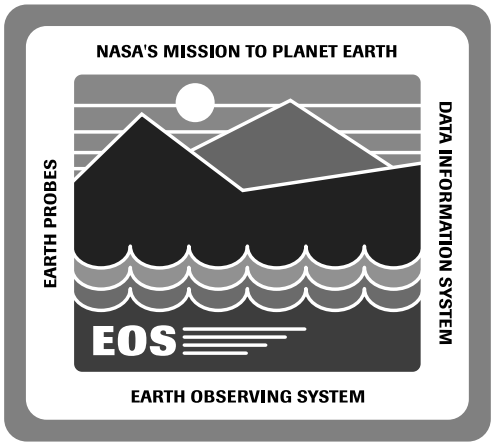
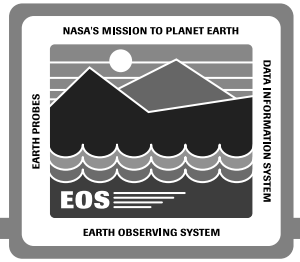


FOS Off-Line Design

Jon Kuntz

18 October 1995

Off-Line Systems



Overview

Subsystems

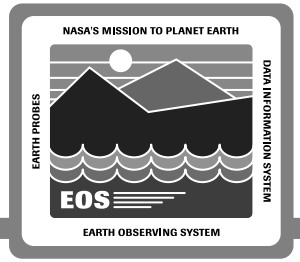
- **Overview**
- **Design Objectives**
- **Design Features**
- **Analyses Performed**

Hardware Mapping

COTS Overview

Off-Line Introductions

Overview



Off-line Processing Managed By Three FOS Subsystems

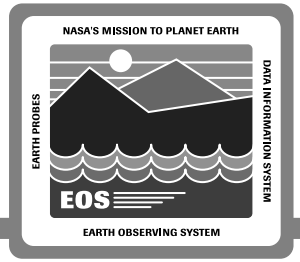
- **Data Management**
- **Command Management**
- **Analysis**

Off-line Systems Exclusive of Planning and Scheduling

Services Provided by Other Subsystems Integrated Into the Off-line Processing Environment

- **Resource Management**
- **Telemetry**
- **User Interface**
- **Planning and Scheduling**
- **Real Time Contact Management**

DMS Overview



Project Data Base Management

- **Input**
- **Validation**
- **Operational Data Generation**

Event Processing

Telemetry Archive

- **Single contiguous archive from R/T and P/B data**

Ground Telemetry Archive

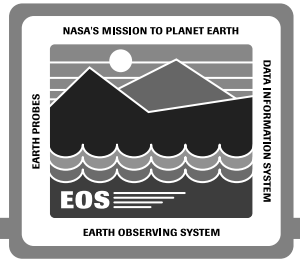
- **NCC ODMs and EDOS CODAs**

External Interfaces

- **EDOS**
- **FDF**
- **SDPS**

File Access Utilities

DMS Design Objectives



Develop a Data Storage and Retrieval strategy to minimize processing time

Take full advantage of the capabilities provided by COTS RDBMS

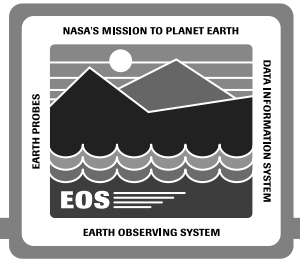
Ensure that all historical data is processed using the database that was valid at the time the data was generated

- **Over-Ride capability is provided**

Provide Access to all Data throughout the Life of the Mission

Develop a Strategy to Support the Use of an Operational Database and Test Database Simultaneously

DMS Design Features



Database

- **Provide GUI for the FOS Database**
  - **Editing**
  - **Reporting**
- **Maintain copy of all valid databases used operationally**
- **Operational and test databases can be used simultaneously**

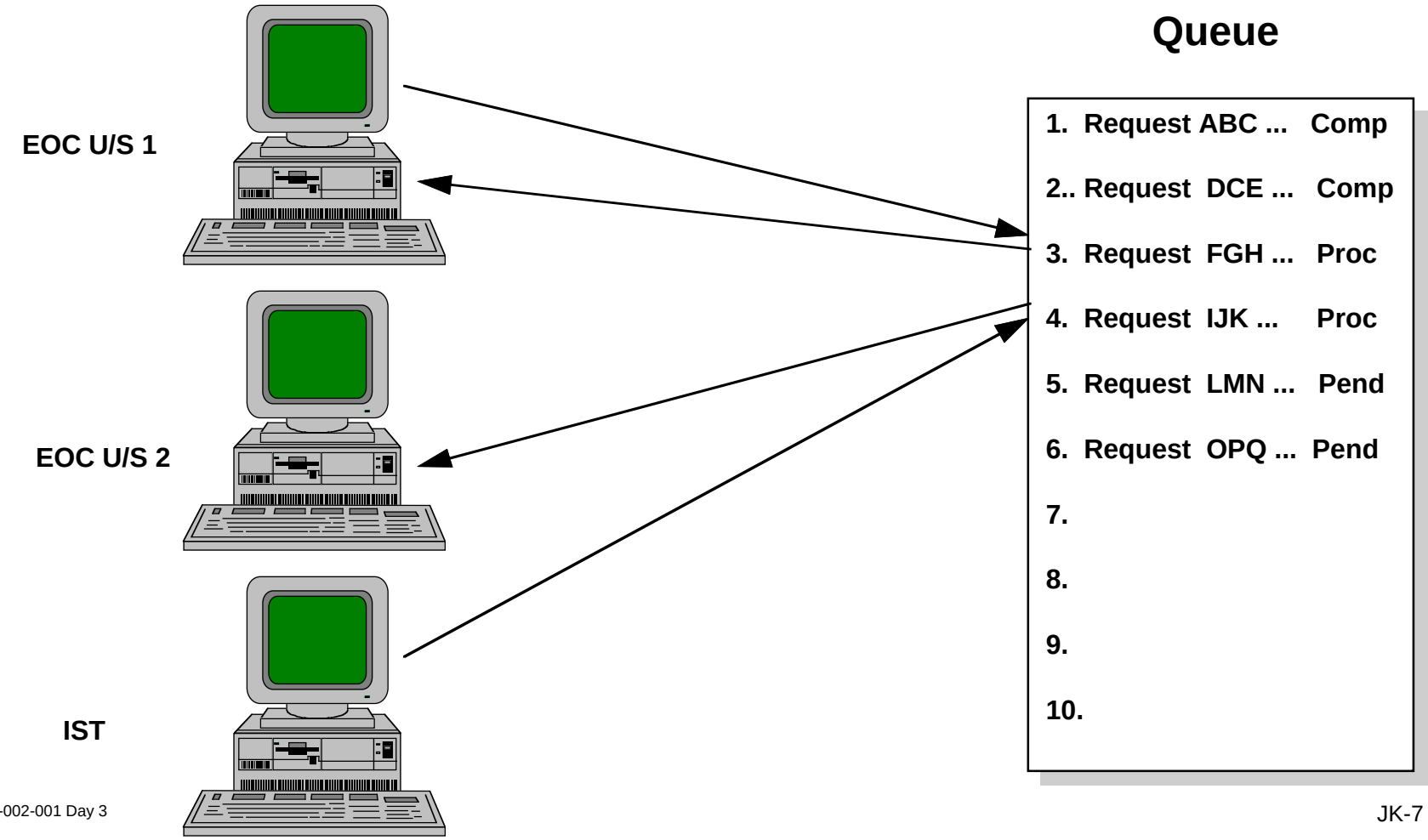
Queue

- **Maintain single centralized queue for processing telemetry requests**
- **Displayable**
- **Prioritize entries**
- **Modifiable**

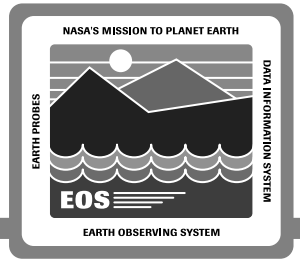
Data Retrieval

- **EOC User Stations read directly from Data Storage Unit**

DMS Design Features



DMS Design Features



Event Filtering

- **User selectable (subsystem, type, spacecraft)**
- **Triggers**
  - **Procedures automatically initiated based upon event ID**

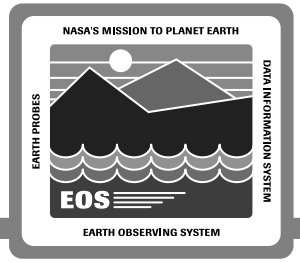
Automated Disk Management

- **Files cleaned off public disk automatically**
- **Storage and retrieval to GSFC DAAC transparent**

Centralized Input for External Data

- **EDOS**
- **FDF**
  - **Receipt of FDF data automated**

DMS Design Features



Merge

- **Automatic merging of real time and playback data**
  - **Time ordered archive**
- **Initiates Analysis processing for system generated statistics**

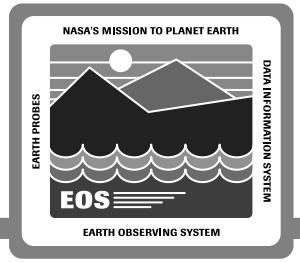
Metadata

- **Displayable**
- **Contains information about archived all operational files**

Replay

- **Selectable rates**
- **Replay control**
  - **Pause, Stop, Start, Step**

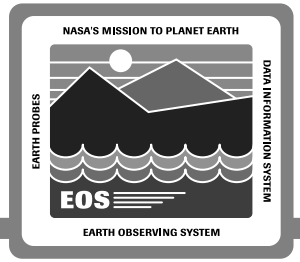
DMS Design Features



IST Analysis Request Processing

- **Provide option to process request at the EOC**
  - **Results stored in EOC if IST not available**
  - **Results downloaded to IST if available**
- **Provide option to process request at the IST**
  - **Search local IST archive before downloading**
  - **Telemetry files downloaded to IST**

DMS Analyses Performed



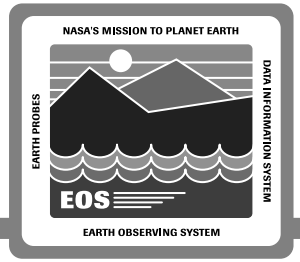
Analyzed the Potential for Having User Stations Retrieve Telemetry Data Directly From the Data Storage Unit

- **Obtained performance results from retrieval prototype**
  - **Results were very favorable for distributed retrieval**
- **PDR design has been updated to reflect distributed telemetry retrieval**

Performed Trade Study to Evaluate COTS Database Products for Use in the FOS

- **Studied and evaluated OODBMS and RDBMS products**
- **OODBMS still immature**
- **Sybase RDBMS selected over Oracle**
  - **No cost to instrument teams for client license**

DMS Analyses Performed



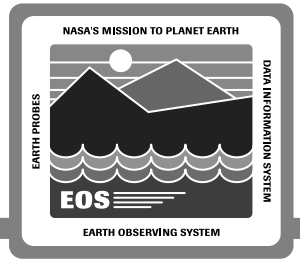
Performed Trade Study to Select Cost Effective Solution to Database Interface Tool

- **Evaluated Persistence and DBTools as application interface to Sybase**
- **Persistence found to be unable to meet FOS requirements**
  - **Limited support for hardware platforms**
  - **Very expensive**
- **DBTools selected as interface tool**
  - **Consistent with RogueWave products as class libraries for FOS**

Performed Study to Determine Storage Strategy for FOS Data

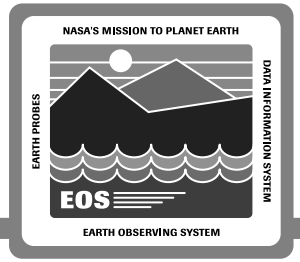
- **UNIX files**
- **Database tables**
- **Required disk space**

DMS Analyses Performed



Item	Size (Mb)	Duration	SDPS .	Table/File	Type	Cfg Ctrl
Telemetry PDB	5	Mission	every rel.	SYBASE	PUBLIC	YES
Command PDB	5	Mission	every rel.	SYBASE	PUBLIC	YES
Activity PDB	5	Mission	every rel.	SYBASE	PUBLIC	YES
Constraint PDB	5	Mission	every rel.	SYBASE	PUBLIC	YES
Telemetry OD	5	Mission	every rel.	FILE	PUBLIC	YES
Command OD	5	Mission	every rel.	FILE/Sybase	PUBLIC	YES
Activity OD	5	Mission	every rel.	FILE/Sybase	PUBLIC	YES
Constraint OD	5	Mission	every rel.	Sybase	PUBLIC	YES
PDB Log	10	Mission	daily	FILE	PUBLIC	YES
PDB Report	5	Mission	daily	FILE	PUBLIC	YES
Events Archive	0.1	7 days	daily	FILE	PUBLIC	YES
Spacecraft Definitions	10	Mission	every rel.	FILE	PUBLIC	YES
Instrument Definitions	10	Mission	every rel.	FILE	PUBLIC	YES
Long term staging	5	Mission	N/A	FILE	PUBLIC	YES

CMS Overview



Load Management

- **ATC**
- **RTCS**
- **Flight Software**
- **Microprocessor**
- **Table**

Ground Script Generation

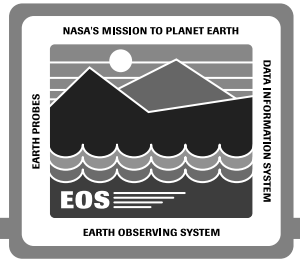
Spacecraft Memory Management

Dump Processing

- **Formatting**
- **Comparisons**

Reports

CMS Design Objectives



Develop Design Infrastructure for Multiple Mission Support

- **Historically CMS's have been very mission specific**
- **Provided little or no reuse from one mission to the next**

Provide an Integrated System

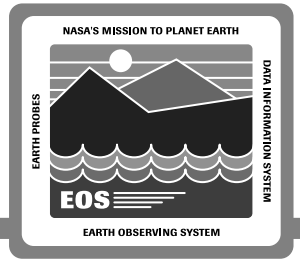
- **CMS integrated with Real Time and Analysis processing as well as Planning and Scheduling**

Provide a Framework to Support Increased Automation

Provide for Mult- thread Processing by the CMS

- **Example: Constraint checking ATC load and procedure simultaneously**

CMS Design Features



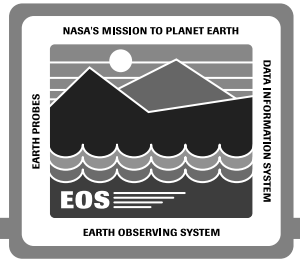
ATC Load

- **Generated from schedule received from P&S**
- **Load partitioning accomplished automatically by CMS**
- **Uplink scheduled automatically by CMS, reflected in Ground Script**
- **Continuity between loads ensured**

Ground Script

- **Generated from schedule received from P&S**
  - **Provides continuity between load and Ground Script**
- **Contains time ordered sequence of spacecraft and ground commands as well as comments**
- **Provides insight into stored commanding which will occur during each contact and during back orbit**
- **Capable of automating a contact under nominal conditions**
- **Provides framework for increased automation**

CMS Design Features



Command Level Constraint Checking

- **Utilizes database defined rules**
- **Adding/Modifying rules of defined rule types requires only a database update**
- **Simultaneous constraint checking of ATC Load, RTCS, Procedures, and Activities**

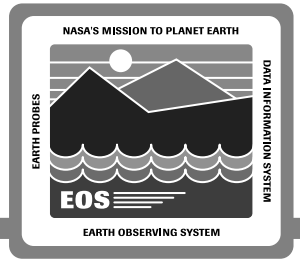
Table Load Builder

- **Utilizes database defined table structures**
- **New tables added without a software change**
- **Table contents validated against database defined structure**

FDF Table Loads

- **Load contents automatically validated and converted to uplinkable load**
- **Uplink automatically scheduled and added to Ground Script**

CMS Design Features



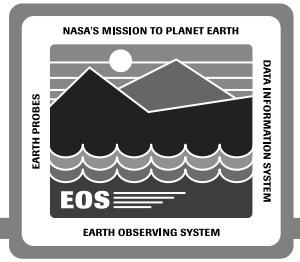
Load Catalog

- **Maintain an entry in the database for each valid load**
- **Load information available to FOT/IOT through Load Manager Tool**

Load Manager Tool

- **Allows for ingest of load contents from SCF or SDVF**
- **Non Mission Specific**
  - **Header info can be entered via Load Manager Tool**
- **Loads created during I&T can be easily migrated to the FOS**

CMS Analyses Performed



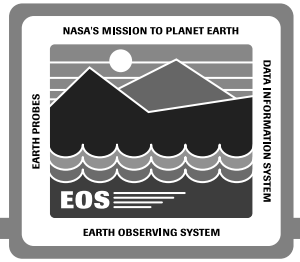
Studied Existing NASA and NOAA CMS's

- **UARS** **EUVE**
- **WIND/POLAR** **SAMPEX**
- **FAST** **SOHO**
- **GIMTACS** **PACS**

Applied Lessons Learned

- **Identified functions which are truly mission specific**
  - **Localized these functions in FOS design**
- **Identified opportunities for integration with R/T**
  - **Load Catalog**
  - **Dump Processing**
  - **S/C State Check**

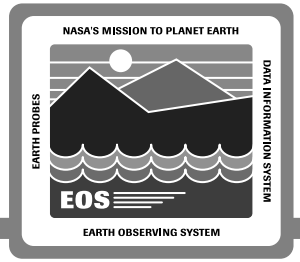
CMS Analyses Performed



Performed In-depth Study of Command Constraints

- **Studied constraint checking on existing systems**
  - **WIND/POLAR CMS**
  - **PARR**
- **Worked with FOT on defining constraint rule types**
- **Implemented lessons learned**
  - **Define constraints in database**
  - **Implement command list as doubly linked list**
  - **Spawn new process to perform constraint checking**

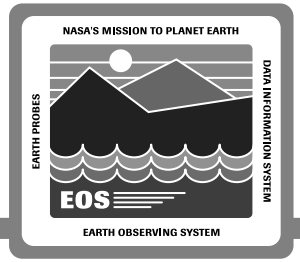
CMS Analyses Performed



Analyzed Options to Streamline the Transition From One Ground Script to the Next

- **Implemented discussions with the FOT to refine the ops concept**
- **Instituted technical interchange meetings between CMS and FUI to improve PDR design**
- **CMS will maintain continuous ground schedule**
  - **New directives merged into the Ground Schedule when DAS is received from P&S**

Analysis Overview



Statistics Generation

User Supplied Algorithm Processing

Decision Support System

- **SSR Model**
- **Spacecraft Activity Log Processing**
- **Expert Advisor**

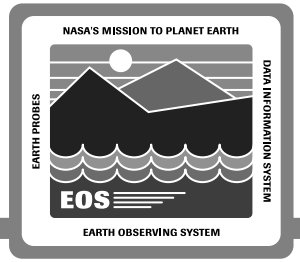
Routine Request Processing

- **Datasets**
- **Reports**

Carryout Data

Clock Correlation

Analysis Design Objectives



Develop a Design Which Would Support Analysis Processing Simultaneously With Real Time On a Non-interference Basis

Optimize Performance

- **Hardware utilization**
- **Integrate Selective Decom**

Provide Processing Flexibility to the FOT/IOT

- **Configurable by the FOT/IOT**

Utilize New Technologies Where Applicable

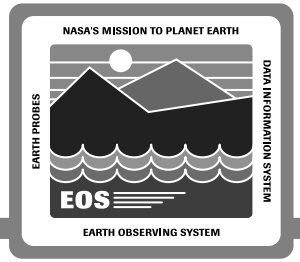
Provide Automatic Processing for Greater Operational Efficiencies

- **System Generated Statistics**
- **Standing Orders**

Provide Automatic Feedback to Real Time and Scheduling Processes to "Complete the Loop"

- **SSR Playback Data to P&S**
- **Clock Correlation generates load and command request**

Analysis Design Features



Dataset

- **Generated as interim product**
- **Provides increased flexibility and efficiency**
  - **Save and reuse**
  - **Overlays**
  - **Plots and/or reports**

System Generated Statistics

- **Computed automatically upon successful merge of back orbit data**
- **Data available for display, no processing required**

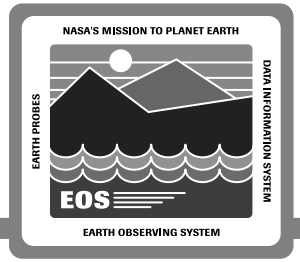
Carryout Data

- **Data formatted to be exported from the FOS**

Algorithms

- **FOT/IOT able to develop customized software that is linked at run time**
- **Extends capabilities of Analysis to meet individualized needs**

Analysis Design Features



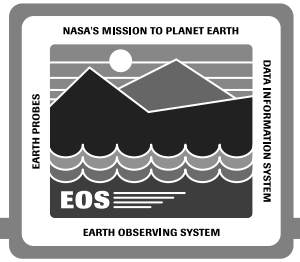
SSR Model

- **Provides insight and recommendations, when appropriate, into status of SSR playback in real time**
- **Provides post contact status info to P&S regarding success of the playback**
  - **P&S utilizes data to update resource model**

Request Manager

- **Coordinates the processing of Analysis requests**
- **Guarantees all available data within requested interval is processed**
- **Provides capability to control processing environment**
  - **Where the request actually gets processed**
- **Handles database crossovers**

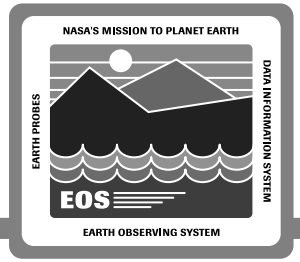
Analysis Design Features



Clock Correlation

- **Analyze drift error in real-time**
  - **Generate table load autonomously if threshold exceeded**
  - **Generate command request to adjust the frequency of the Master Oscillator**
- **Perform Post Contact Analysis**
  - **Calculate drift rate**
  - **Generate report**
  - **Predict out of tolerance**
  - **Generate table load and command request if appropriate**

Analysis Analyses Performed



Verify the Reliability of Dynamic Linking of User Defined Algorithms

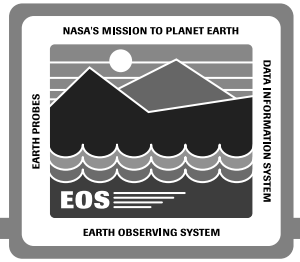
- **Evaluation results indicate dynamic linking is a viable implementation approach**
  - **C and C++ shared objects successfully linked**
  - **FORTRAN shared objects were not successfully linked**

    Continuing to investigate

Upgrade DSS Prototype to Use RTworks

- **Work with FOT to evaluate usability**
  - **FOT found RTworks to be a desirable commodity for the FOS**
- **SSR Tool was easily migrated to RTworks**
  - **Data interface was easily implemented**

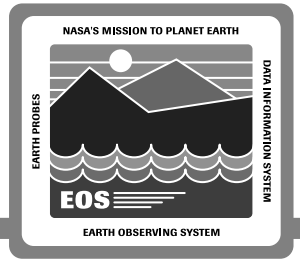
Analysis Analyses Performed



Evaluated ECS Available COTS Products for Performing Numerical Analysis

- **IDL and IMSL were evaluated**
- **Both products were able to meet baseline requirements**
- **IMSL was chosen**
- **IDL will be available if required in future**

Off-Line Hardware Mapping



Real Time Server

DMS
- Archiver
- Data Retriever
- Event Listener
- Event Handler
- Event Retriever

Analysis
- Clock Correlation
- RT Statistics
- SSR

COTS
- RTworks

Data Server

CMS
- Schedule Controller
- Ground Schedule
- Load Catalog
- Spacecraft Model
- Command Model

DMS
- Queue Manager
- Playback Merge
- Event Processing
- Disk Cleaner
- SDPS I/F
- Data Retriever
- File Manager
- PDB Input
- PDB Edit
- PDB Reporting
- PDB Validation
- OD Generation

COTS
- Sybase
- DBTools

User Station

DMS
- Data Retriever
- Event Listener
- Event Handler
- Event Retrieve

Analysis
- Request Manager
- Offline Analysis
- DSS Advisor
- DSS DataServer

COTS
- Sybase
- DBTools
- RTworks
- DBX
- IMSL
- Altair

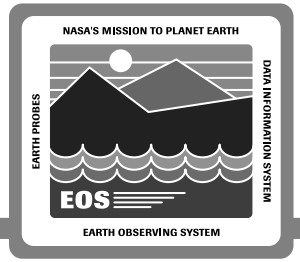
IST

DMS
- Data Retriever
- Event Listener
- Event Handler
- Event Retriever

Analysis
- Request Manager
- Offline Analysis

COTS
- Sybase
- DBTools
- DBX
- IMSL

COTS Overview



Sybase

- **Relational Database Management System (RDBMS)**
- **Ensures data integrity**
- **Provides data access and query capabilities**

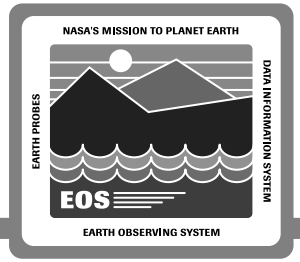
DBTools

- **Class library designed to work with a RDBMS**
- **Provides interface between C++ and RDBMS**

DB Xcessory

- **Visual development environment**
- **Allows developers to build Motif interfaces to RDBMS directly without writing X, Motif or SQL code**
- **Editing and reporting**

COTS Overview



IMSL

- **Library of mathematical functions for Off-Line Analysis processing**
  - **Numerical analysis**
  - **Curve fitting**

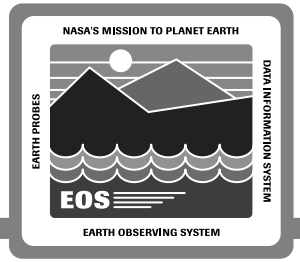
RTworks

- **Rule based expert system**
  - **Easily integrated Into FOS architecture**
  - **Provides GUI for input and editing of rules**

Altair

- **Expert system tool**
  - **Operates in concert with RTworks**
  - **Provides state recognition engine**

Off-Line Introductions



Data Management

- **Carol Lloyd** — **Project Data Base**
- **Dave Peters** — **DMS Applications**

Command Management

- **Theresa Brandt** — **CMS Applications**

Analysis

- **Kevin Robair** — **Analysis Applications**